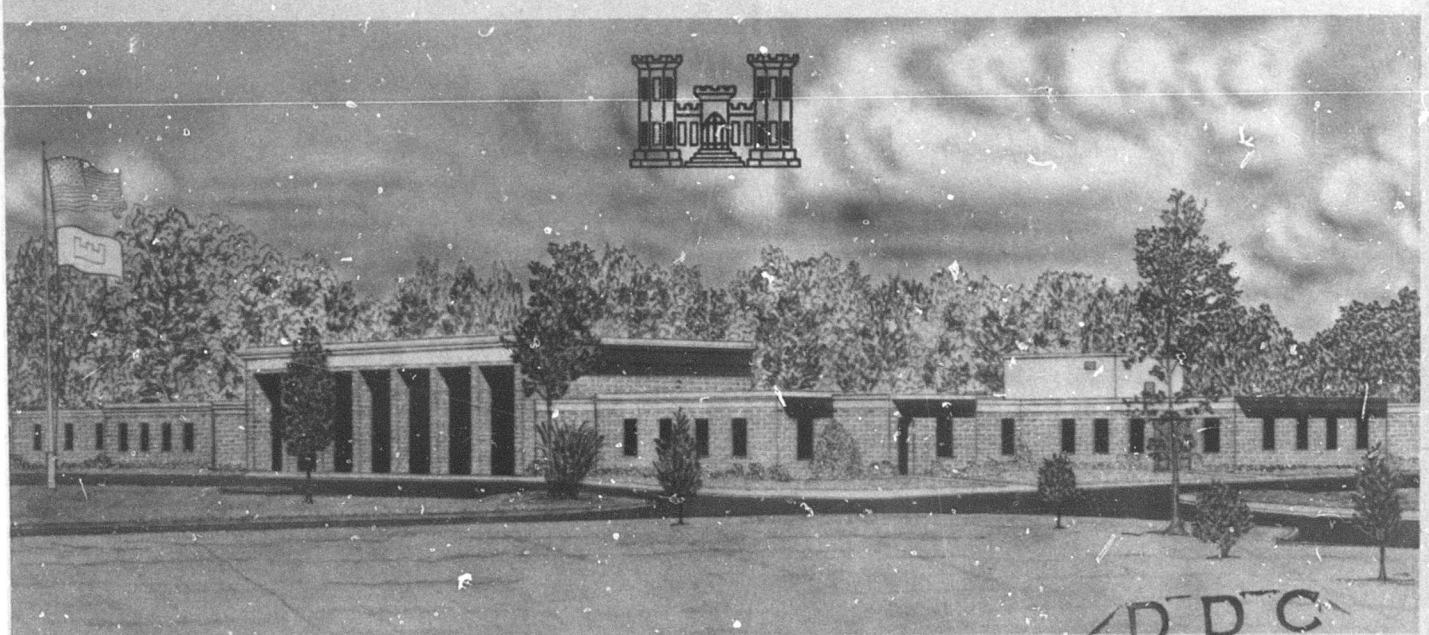
INSTRUCTION REPORT S-70-1

RAPID ASSESSMENT OF SOIL STRENGTH AT AIRCRAFT LANDING SITES

by

G. M. Hammitt II



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Sponsored by Office, Chief of Engineers, U. S. Army

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ARMY-MRC VICKSBURG, MISS.

Foreword

This report was prepared as part of the work authorized by the Office, Chief of Engineers, in "Instruction and Outline for Technical Support -- Army, FY 1967" dated May 1966. Personnel of the Flexible Pavement Branch, Soils Division, U. S. Army Engineer Waterways Experiment Station (WES), conducted this study for the Civil Engineering Branch, Engineering Division, Military Construction, Office, Chief of Engineers.

This report was written by Mr. G. M. Hammitt II under the general supervision of Messrs. R. G. Ahlvin, D. N. Brown, and A. A. Maxwell of the Soils Division, WES.

Director of the WES during the preparation of this report was COL Levi A Brown, CE. Technical Director was Mr. F. R. Brown.

Contents

Conversion Factors, British to Metric Units of Measurement

British units of measurement used in this report can be converted to metric units as follows:

Multiply	By	To Obtain
inches	2.54	centimeters
pounds	0.45359237	kilograms
tons	907.185	kilograms

RAPID ASSESSMENT OF SOIL STRENGTH AT AIRCRAFT LANDING SITES

General

1. Numerous occasions arise in which the tactical situation does not permit a standard evaluation of the condition of isolated landing strips. The soil strength measuring equipment and the specially trained personnel needed to perform such an evaluation are commonly not available in forward areas. The method reported herein will permit (without special equipment and with only the guidance presented herein) a direct and very rapid determination of the ability of an area to support aircraft traffic.

Background

2. A complex of information based on many years of research in aircraft landing area requirements has led to a means of relating the response of unpaved areas to aircraft operations. A similar complex of information in ground vehicle mobility has led to a means of relating the response of ground surfaces of various strengths to vehicular traffic. The correlation of information in these two areas makes it possible to use the response of an area to ground vehicles to forecast the aircraft-supporting capability of the area. These two complexes of information have been combined to provide a rapid means of assessing landing sites, and carefully controlled prototype tests have been conducted to verify the resulting method.*

Method

3. This report presents a means of assessing aircraft landing-site capability directly from the response of the site to one pass of a ground vehicle. Table 1 relates the behavior of the supporting surface under each of four standard military ground vehicles to the requirements for

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* G. M. Hammitt II, "Evaluation of Soil Strength of Unsurfaced Forward Airfields by Use of Ground Vehicles," Miscellaneous Paper (in preparation), U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

operation of various military aircraft on unsurfaced landing fields. The table can be used as a general guide on all soils except loose, dry sands or fine gravels. For loose sand or fine gravel sites, this method will give a greatly conservative prediction.

4. The method involves simply selecting one of the four standard military ground vehicles shown in table 1 and traversing the proposed landing site one time. After observation and/or measurement of the resulting rut depth, table 1 is used to determine the ability of the site to sustain aircraft traffic.

> EXAMPLE: Several landings of a fully loaded U-1A aircraft are scheduled to deliver material to an isolated landing zone. An empty 2-1/2-ton* M34 truck is available and is used to drive over the proposed landing site once. An average rut depth of 0.25 in. is observed. From information in table 1 for an empty M34 truck and 0.25-in. rutting, it is determined that the site will support at least one operation of the U-1A but not as many as 10.

Applicability

5. This method of assessment provides an expedient means of obtaining an indication of soil strength as related to aircraft operations and is intended as a rapid substitute for more deliberate methods. Existing standard methods, such as CBR and penetrometer measurements, should be employed when equipment is available and when time requirements permit their use.

6. The method is primarily intended for initial site assessment, but may be used with equal success for periodic reassessment, based on changes in moisture conditions. For conditions in which only the upper surface is weakened, the surface could be scraped and then more appropriate values noted.

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* A table of factors for converting British units of measurement to metric units is presented on page vii.

TABLE 1

STANDARD MILITARY GROUND VEHICLES RELATED TO OPERATION OF MILITARY AIRCRAFT ON UNSURFACED FIELDS

VEHICLE	VEHICLE WEIGHT LB	RUT DEPTH IN.	AIRCRAFT LOADING	AIRCRAFT OPERATIONS*	PREDICTED OPERATIONAL CAPABILITY FOR VARIOUS TYPES OF AIRCRAFT**											
					O-1	U-6	C-45	U-1A	U-8	C-7A	C-47	OV-1	CH-47	CH-54	C-123	C-130
1/4-TON, 4 x 4 M151 TRUCK	2,473 EMPTY	0	EMPTY	1	■	■	■	■	■	■	■					
				10	■	■	■	■	■	■	■					
				100	■	■	■	■								
			FULL LOAD	1	■	■	■	■	■	■	■					
				10	■	■	■	■	■	■	■					
				100	■	■	■	■								
		TRACE 0.1	EMPTY	1	◢	■	■	■	■	■	■					
				10		■	■	■	■	■	■					
				100												
			FULL LOAD	1												
				10												
				100												
		0.25	EMPTY	1	◢											
				10												
				100												
			FULL LOAD	1												
				10												
				100												
	3,000 DRIVER AND 3 PASSENGERS	0	EMPTY	1	■	■	■	■	■	■	■	■				
				10	■	■	■	■	■	■	■	■				
				100	■	■	■	■								
			FULL LOAD	1	■	■	■	■	■	■	■					
				10	■	■	■	■	■	■	■					
				100	■	■	■	■								
		TRACE 0.1	EMPTY	1	■	■	■	■	■	■	■					
				10	■	■	■	■	■	■	■					
				100	■	■	■	■								
			FULL LOAD	1	■	■	■	■	■	■	■					
				10	■	■	■	■	■	■	■					
				100	■	■	■	■								
		0.25	EMPTY	1	■	■	■	■	■	■	■					
				10	■	■	■	■	■	■	■					
				100	■	■	■	■								
			FULL LOAD	1												
				10												
				100												

* One operation is one takeoff and one landing.

** ■ Aircraft can operate at indicated loading.

□ Aircraft cannot operate at indicated loading.

◢ Aircraft may be able to operate at indicated loading with calculated risk.

TABLE 1 (Continued)

VEHICLE	VEHICLE WEIGHT LB	RUT DEPTH IN.	AIRCRAFT LOADING	AIRCRAFT OPERATIONS*	PREDICTED OPERATIONAL CAPABILITY FOR VARIOUS TYPES OF AIRCRAFT**											
					0-1	U-6	C-45	U-1A	U-8	C-7A	C-47	OV-1	CH-47	CH-54	C-123	C-130
3/4-TON, 4x4 M37 TRUCK	5,950 EMPTY	0	EMPTY	1												
				10												
				100												
			FULL LOAD	1												
				10												
				100												
		0.1	EMPTY	1												
				10												
				100												
		0.1	FULL LOAD	1												
				10												
				100												
		0.25	EMPTY	1												
				10												
				100												
			FULL LOAD	1												
				10												
				100												
	7,800 LOADED	0	EMPTY	1												
				10												
				100												
			FULL LOAD	1												
				10												
				100												
		TRACE 0.1	EMPTY	1												
				10												
				100												
			FULL LOAD	1												
				10												
				100												
		0.25	EMPTY	1												
				10												
				100												
			FULL LOAD	1												
				10												
				100												
		0.50	EMPTY	1												
				10												
				100												

* One operation is one takeoff and one landing.

** Aircraft can operate at indicated loadings.

Aircraft cannot operate at indicated loading.

Aircraft may be able to operate at indicated loading with calculated risk.

TABLE 1 (Continued)

VEHICLE	VEHICLE WEIGHT LB	RUT DEPTH IN.	AIRCRAFT LOADING	AIRCRAFT OPERATIONS*	PREDICTED OPERATIONAL CAPABILITY FOR VARIOUS TYPES OF AIRCRAFT**											
					0-1	U-6	C-45	U-1A	U-8	C-7A	C-47	OV-1	CH-47	CH-54	C-123	C-130
2-1/2-TON, 6x6 M34 TRUCK	13,900 EMPTY	0	EMPTY	1												
				10												
				100												
			FULL LOAD	1												
				10												
				100												
		TRACE 0.1	EMPTY	1												
				10												
				100												
			FULL LOAD	1												
				10												
				100												
		0.25	EMPTY	1												
				10												
				100												
			FULL LOAD	1												
				10												
				100												
		0.5	EMPTY	1												
				10												
				100												
			FULL LOAD	1												
				10												
				100												
		1.0	EMPTY	1												
				10												
				100												

* One operation is one takeoff and one landing.

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.E 1 (Continued)

VEHICLE	VEHICLE WEIGHT LB	RUT DEPTH IN.	AIRCRAFT LOADING	AIRCRAFT OPERATIONS*	PREDICTED OPERATIONAL CAPABILITY FOR VARIOUS TYPES OF AIRCRAFT**
					0-1 | U-6 | C-45 | U-1A | U-8 | C-7A | C-47 | OV-1 | CH-47 | CH-54 | C-123 | C-130
2-1/2-TON, 6x6 M34 TRUCK (Continued)	24,300 LOADED	0	EMPTY	1 10 100	
			FULL LOAD	1 10 100	
		TRACE 0.1	EMPTY	1 10 100	
			FULL LOAD	1 10 100	
		0.25	EMPTY	1 10 100	
			FULL LOAD	1 10 100	
		0.50	EMPTY	1 10 100	
			FULL LOAD	1 10 100	
		1.0	EMPTY	1 10 100	
			FULL LOAD	1 10 100	

* One operation is one takeoff and one landing.

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□ Aircraft cannot operate at indicated loading.

◢ Aircraft may be able to operate at indicated loading with calculated risk.

TABLE 1 (Concluded)

VEHICLE	VEHICLE WEIGHT LB	RUT DEPTH IN.	AIRCRAFT LOADING	AIRCRAFT OPERATIONS*	PREDICTED OPERATIONAL CAPABILITY FOR VARIOUS TYPES OF AIRCRAFT** 0-1	U-6	C-45	U-1A	U-8	C-7A	C-47	OV-1	CH-47	CH-54	C-123	C-130
5-TON, 6 x 6 M55 TRUCK	24,064 EMPTY	0	EMPTY	1 10 100												
			FULL LOAD	1 10 100												
		TRACE 0.1	EMPTY	1 10 100												
			FULL LOAD	1 10 100												
		0.25	EMPTY	1 10 100												
			FULL LOAD	1 10 100												
		0.50	EMPTY	1 10 100												
			FULL LOAD	1 10 100												
		1.0	EMPTY	1 10 100												
			FULL LOAD	1 10 100												
		2.0	EMPTY	1 10 100												
			FULL LOAD	1 10 100												

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13. ABSTRACT

This report presents a method of rapidly assessing the ability of an area to support aircraft operations. The method involves no special equipment or specially trained personnel, but is based on the interrelation of the response of ground surfaces of various strengths to vehicular and aircraft traffic. Data that allow the forecasting of the ability of an area to support aircraft traffic are tabulated herein. This ability is based on the rut depth occurring in a soil after one pass of a standard military vehicle.

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